

2.10 Derivatives of $\tan x$, $\cot x$, $\sec x$, and $\csc x$

Name: _____ Class: _____ Date: _____

Total: 9 marks

Objective

Build the skills to answer exam questions on **the derivatives of tangent, cotangent, secant, and cosecant**.

You must be able to:

- state and use the derivatives of the four remaining **trigonometric functions** 三角函数

1 Worked examples

Study these first. Each one shows the method for a question type used later.

■ More trig derivatives

$$\frac{d}{dx}[\tan x] = \sec^2 x, \quad \frac{d}{dx}[\cot x] = -\csc^2 x,$$

$$\frac{d}{dx}[\sec x] = \sec x \tan x, \quad \frac{d}{dx}[\csc x] = -\csc x \cot x.$$

2 Practice

2.1 State $\frac{d}{dx}[\tan x]$. [1]

2.2 State $\frac{d}{dx}[\sec x]$. [1]

2.3 State $\frac{d}{dx}[\cot x]$ and $\frac{d}{dx}[\csc x]$. [2]

3 Exam-style questions

3.1 $\frac{d}{dx}[\tan x]$ equals [1]

- **A** $\sec^2 x$
 - **B** $-\csc^2 x$
 - **C** $\sec x \tan x$
 - **D** $-\sin x$
-

3.2 $\frac{d}{dx}[\sec x]$ equals [1]

- **A** $\sec^2 x$
 - **B** $\sec x \tan x$
 - **C** $-\csc x \cot x$
 - **D** $\tan x$
-

3.3 Differentiate each.

(a) $\tan x$. [1]

(b) $\cot x$. [1]

(c) $\csc x$. [1]

4 Go further

- work through the **2.10 Finding the Derivatives of Tangent, Cotangent, Secant, and/or Cosecant Functions** lesson on the **Learn** page;
- read the **Differentiation: Definition and Fundamental Properties** section of the AP Calculus AB handout on the **Know** page.

Solutions

2.1 $\sec^2 x$.

2.2 $\sec x \tan x$.

2.3 $\frac{d}{dx}[\cot x] = -\csc^2 x$; $\frac{d}{dx}[\csc x] = -\csc x \cot x$.

3.1 A.

3.2 B.

3.3 (a) $\sec^2 x$. (b) $-\csc^2 x$. (c) $-\csc x \cot x$.